SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
MONITORING AND ANALYSIS

Mira Loma PM_{10} Monitoring

Sampling Conducted
December, 2000 and January, 2001

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ABSTRACT

Purpose

In Fall 2000, Mira Loma residents expressed concerns to the AQMD about the potential for increased air pollution in their community due to an expected increase in commercial diesel truck traffic. In response, the AQMD initiated a two-month particulate monitoring program in December, 2000 and January, 2001 to assess existing PM_{10} levels including elemental carbon, with comparisons to nearby sites.

Elemental carbon is an indicator for diesel soot, the primary contributor to air toxic cancer risks in the South Coast Air Basin, as described in the MATES-II study.

Sampling

Sampling was conducted in Mira Loma coincident with the AQMD PM_{10} monitoring network one-in-six day schedule from December 2, 2000 through January 31, 2001. Three additional sites were selected from the AQMD PM_{10} network for carbon analysis and data comparison. Two sites, Rubidoux and Ontario, are the closest particulate monitoring sites to the Mira Loma site. The third site, Los Angeles, was selected to represent conditions within the urban core.

Key Findings

1. Mira Loma PM_{10} levels were higher than all other sites including Rubidoux , a community with one of the consistently highest levels of particulate in the Basin. (Longer-term monitoring in Mira Loma, conducted by the California Air Resources Board as part of the Children's Health Study, may further add to our understanding of particulate pollution in the eastern South Coast Air Basin.)

2. Elemental carbon concentrations in Mira Loma were less than levels measured in Los Angeles, but slightly higher than those observed in the nearby communities of Ontario and Rubidoux. This suggests a contribution of elemental carbon particulate by local sources.

3. Organic carbon levels in Mira Loma were the highest among the sites in the study. Recent studies by others suggest that the most likely source of these particles is from re-entrained road dust.

1.0 PURPOSE AND SCOPE

The AQMD conducted an ambient particulate monitoring program in December, 2000 and January, 2001 in response to concerns expressed by members of the community of Mira Loma, regarding the potential impact of increased diesel truck traffic in their area.

In order to assess existing conditions in Mira Loma, the AQMD initiated sampling of particulate matter less than 10 microns in aerodynamic diameter (PM_{10}). Samples collected were analyzed for mass, from which ambient PM_{10} concentrations were calculated – and for carbon, including speciation of organic carbon and elemental carbon fractions. Of these two carbon species, elemental carbon is associated with transportation sources and with diesel engines in particular. Elemental carbon has been used to estimate the air toxic cancer risks attributable to diesel particulates.[1] Consequently, the ambient concentration of elemental carbon in Mira Loma was a key focus of this study.

Concurrent with the Mira Loma samples, samples were taken and analyzed from sites in Central Los Angeles, Ontario, and Rubidoux. The results are presented and compared in this report.

2.0 PROJECT DISCUSSION

It should be noted that the Mira Loma site in this study is part of the California Air Resources Board's Children's Health Study (CHS). Integrated two-week fine particulate samples have been collected over several years by the ARB, but the nature of the integrated sampling does not lend itself to direct comparisons of particulate samples collected via Federal Reference Method (FRM) PM_{10} samplers at AQMD sites. Hence, for the purpose of this study, an FRM PM_{10} sampler was installed at the Mira Loma monitoring station (10551 Bellegrave Ave., Mira Loma, CA.) In addition, AQMD and CHS laboratory analytical techniques for elemental carbon differ, with the AQMD's techniques consistent with those typically used for ambient air measurements. Thus, AQMD sampling and laboratory methods used in this study are consistent with those used in the MATES-II study.

For comparative purposes, samples collected at existing PM_{10} network sites in Central Los Angeles, Ontario, and Rubidoux were included in the study. Samples were collected on a one-in-six day sampling schedule, coinciding with PM_{10} network sampling dates, from December 2, 2000 through January 31, 2001. The resulting data set consists of 11 samples at each of 4 sampling sites (with the exception of the Ontario station, where no sample was obtained January 1, 2001) for a total of 43 samples.

[1] South Coast Air Quality Management District. (November 1999). *Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES-II)*. Diamond Bar, CA

The AQMD maintains a PM_{10} monitoring network throughout the South Coast Air Basin (the Basin). The SSI PM_{10} samplers utilized in the PM_{10} network were reviewed in a recent AQMD report, paraphrased here[2]:

> The SSI sampler used in this study is the EPA's FRM sampler found in 40CFR50 Appendix J. It is used to monitor PM less than 10 microns in size (PM10). For the purposes of this study, the SSI samplers are used to collect PM_{10} samples, which were also used for the determination of organic carbon (OC), elemental carbon (EC) and total carbon.
>
> The SSI sampler contains a pump controlled by a programmable timer. An elapsed time accumulator, linked in parallel with the pump, records total pump-operation time in hours. During operation, a known quantity of air is drawn through a particle size separator, which achieves particle separation, by impaction. The correct flow rate through the inlet is critical to collection of the correct particle size so that after impaction, only particles 10 microns in size or less remain suspended in the airstream. The flow of air then passes through a quartz filter medium, upon which the particles are collected. A programmable timer automatically turns the pump off at the end of the 24-hour sampling period.
>
> Once a sample has been collected it is returned to the laboratory, following chain-of-custody protocols, where both PM_{10} mass and carbon content are determined. Ambient PM_{10} mass is determined by subtracting the weight of the clean unsampled filter (measured in the laboratory prior to sampling) from the weight of the sampled filter containing the collected PM_{10}, to yield the mass of the PM_{10} collected on the filter. This mass is then divided by the amount of air drawn through the filter to give the ambient concentration, expressed as mass per cubic meter ($\mu g/m^3$).
>
> Ambient carbon levels are determined by taking a small portion of the PM_{10} filter and putting it into a carbon analyzer. The analyzer consists of a computer-controlled programmable oven, computer controlled gas flows, a laser, and a flame ionization detector (FID). The sample is first heated in the oven in increasing amounts of oxygen. As the temperature rises, first organic carbon and then elemental carbon are evolved from the filter. The laser beam passes through the filter, and the transmitted intensity increases at the detector as the light-absorbing carbon leaves the filter, causing the filter to become less black. The evolved carbon is swept from the oven by gas flow, and is transported to the FID where it is detected (in the form of methane) throughout the heating process. The computer that controls these processes collects data on the oven temperature profile, laser light absorption, and FID response to determine the OC and EC content of the filter. This information, combined with the volume of air sampled, provides the OC and EC concentration in the ambient air.

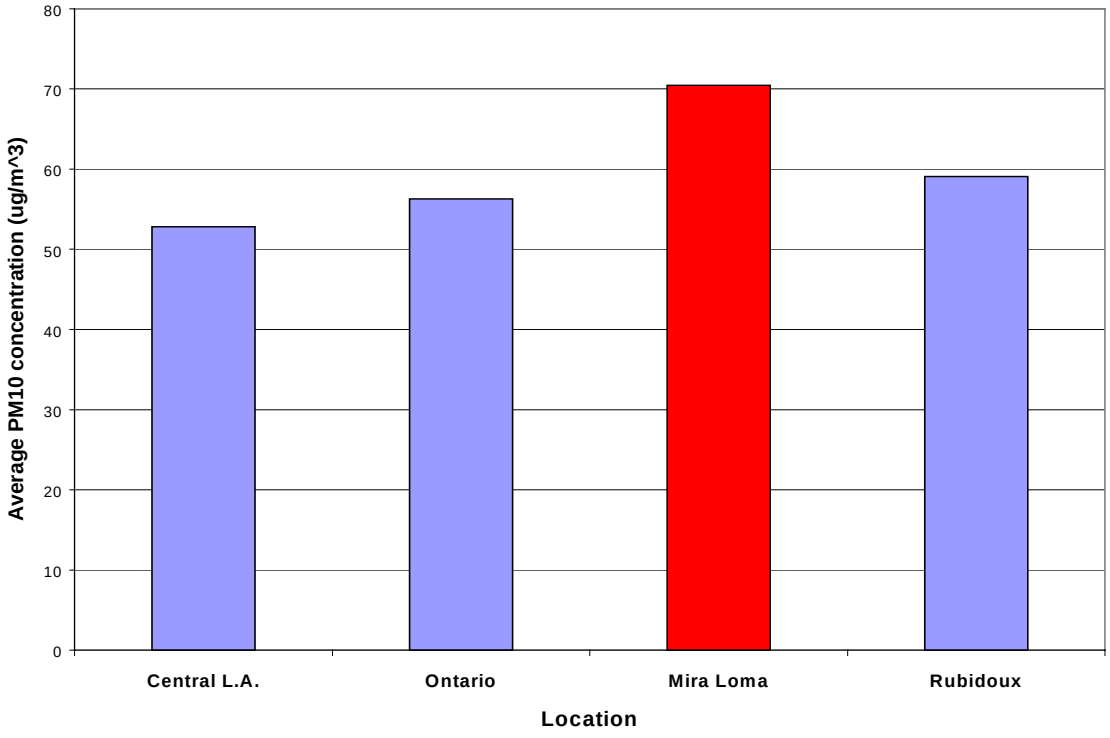
[2] South Coast Air Quality Management District. (April 2000). *Air Monitoring Study in the Area of Los Angeles International Air Port, Part I.* Diamond Bar, CA.

The selection of PM_{10} network sites for inclusion in the study was based on several factors. Basin particulate pollution patterns observed in the past include an increase in PM_{10} from west to east and a decrease in the percentage of elemental carbon in PM_{10} from west to east. These patterns correspond to a decreasing west-to-east gradient of heavy-duty vehicle traffic. Ontario was selected for the study by virtue of its westerly location with respect to Mira Loma, while Rubidoux was selected due to its location nearer the eastern end of the Basin. Further, Rubidoux's rural farming/dairy/residential land usage approximates that of Mira Loma. Central Los Angeles was selected for its high concentration of heavy-duty vehicle traffic, and typically a higher ambient elemental carbon, observed in the metropolitan area.

3.0 DATA ANALYSIS

3.1 PM10 AMBIENT CONCENTRATION ANALYSIS

Figure 1: Average PM_{10} Concentration by Site



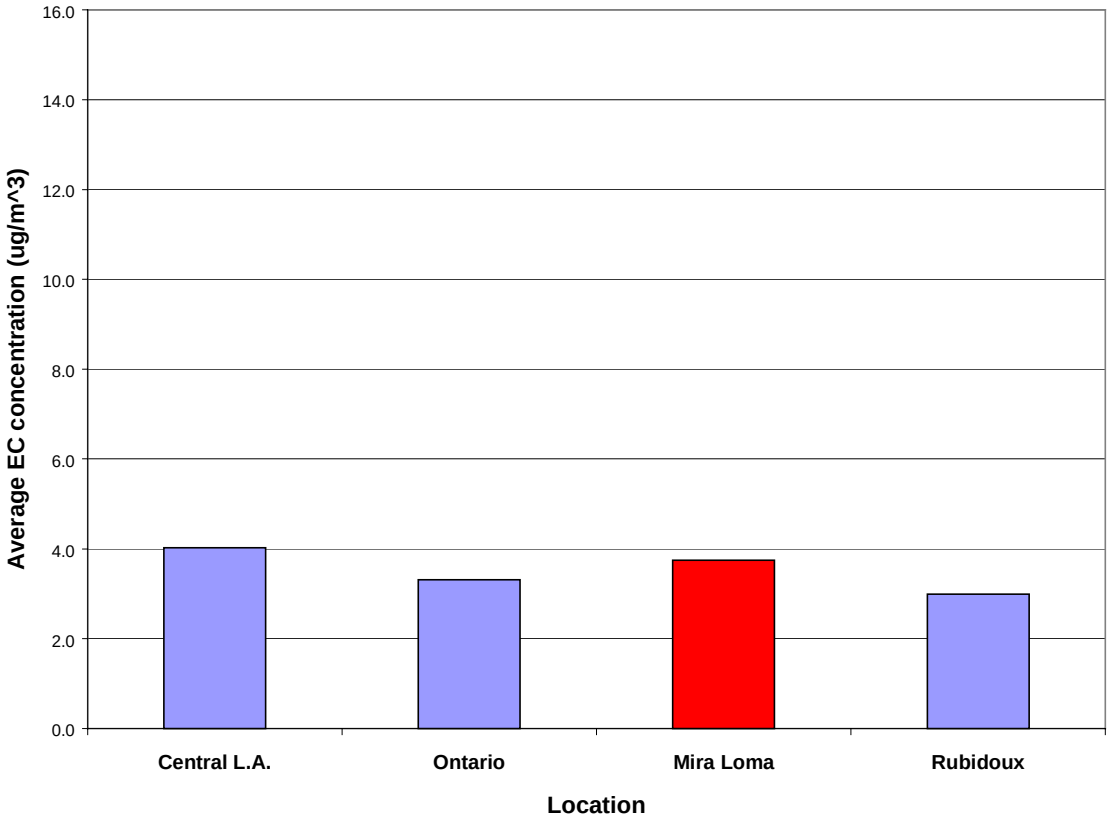
PM_{10} concentrations were averaged for each site over the duration of the study, and results are represented in Fig. 1 above. Complete data tabulation can be found in Appendix I. Both the average value and the individual data points are observed to be consistently higher for Mira Loma during the course of the study. The averages for the remaining sampling locations present the expected pattern discussed earlier: an increase in ambient particulate concentration from west (Central Los Angeles) to east (Rubidoux) with an intermediate value observed in Ontario.

When looking at these results, it must be kept in mind that PM_{10} consists of a variety of chemical species.[3] These include carbonaceous components (EC and OC), crustal materials and wind-blown soils, sulfate and nitrate formed by precursor SOx and NOx emissions primarily as a result of combustion, and ammonium particulate resulting in part from livestock operations, among others. For Mira Loma, contributions from all of these sources are relevant.

The state of California has established 50μg/m^3 as the PM_{10} 24-hour standard. Six of eleven sampling events at Mira Loma exceeded this standard, as did six of eleven at Central Los Angeles, five of eleven at Rubidoux, and five of ten at Ontario. PM_{10} concentrations are characteristically highest in late fall and early winter in the Basin.

3.2 ELEMENTAL CARBON ANALYSIS

Figure 2: Average Elemental Carbon Concentration by Site

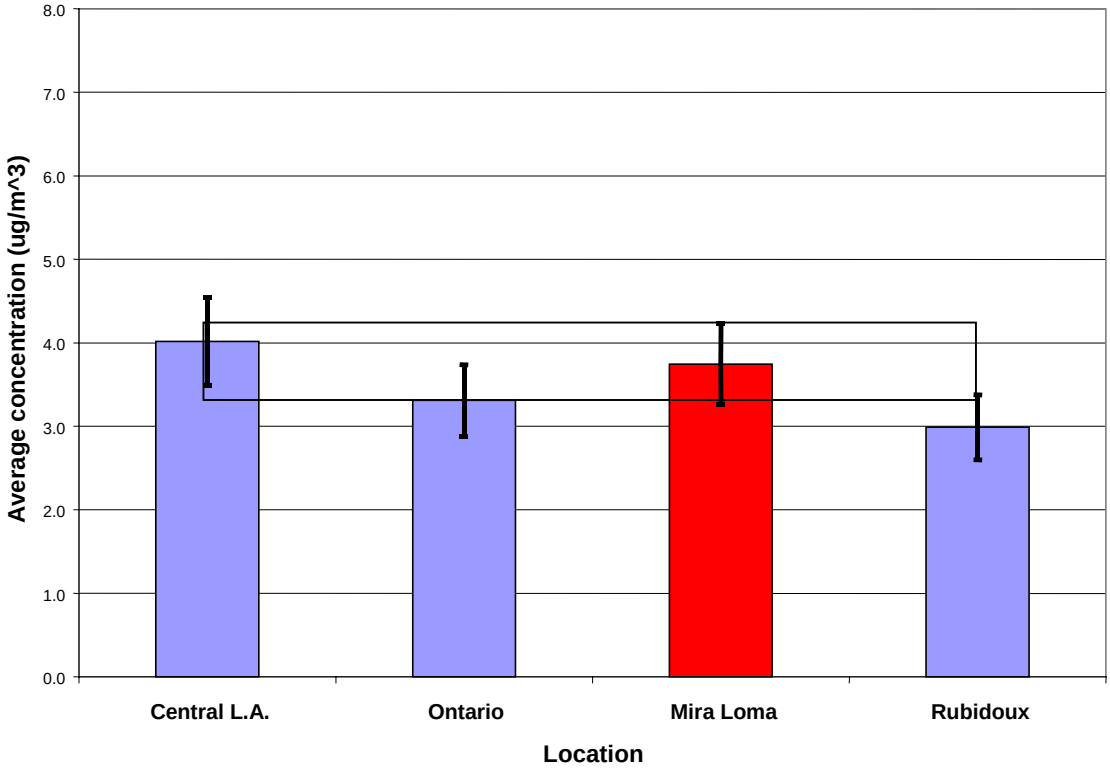


Elemental carbon concentrations were averaged for each site over the duration of the study, and results are represented in Fig. 2 above. Complete data tabulations can be found in Appendix I. The elemental carbon concentration for Mira Loma was higher

[3] Kim. B.M., Teffera, S., Zeldin, M.D. Characterization of $PM_{2.5}$ and PM_{10} in the South Coast Air Basin of Southern California: Part 1 – Spatial Variations. *J. Air and Waste Manage. Assoc.* **2000** 50:2034-2044.

than that observed for either Rubidoux or Ontario, but not as high as the levels measured in Los Angeles. Using EC as a diesel surrogate, the Mira Loma values may indicate a heavier diesel contribution to PM_{10} as compared to the nearby sites. This observation suggests that the ambient EC concentration in Mira Loma is being increased by local emissions. It should be noted that the EC data provided by the current study are suggestive, not definitive, of cause.

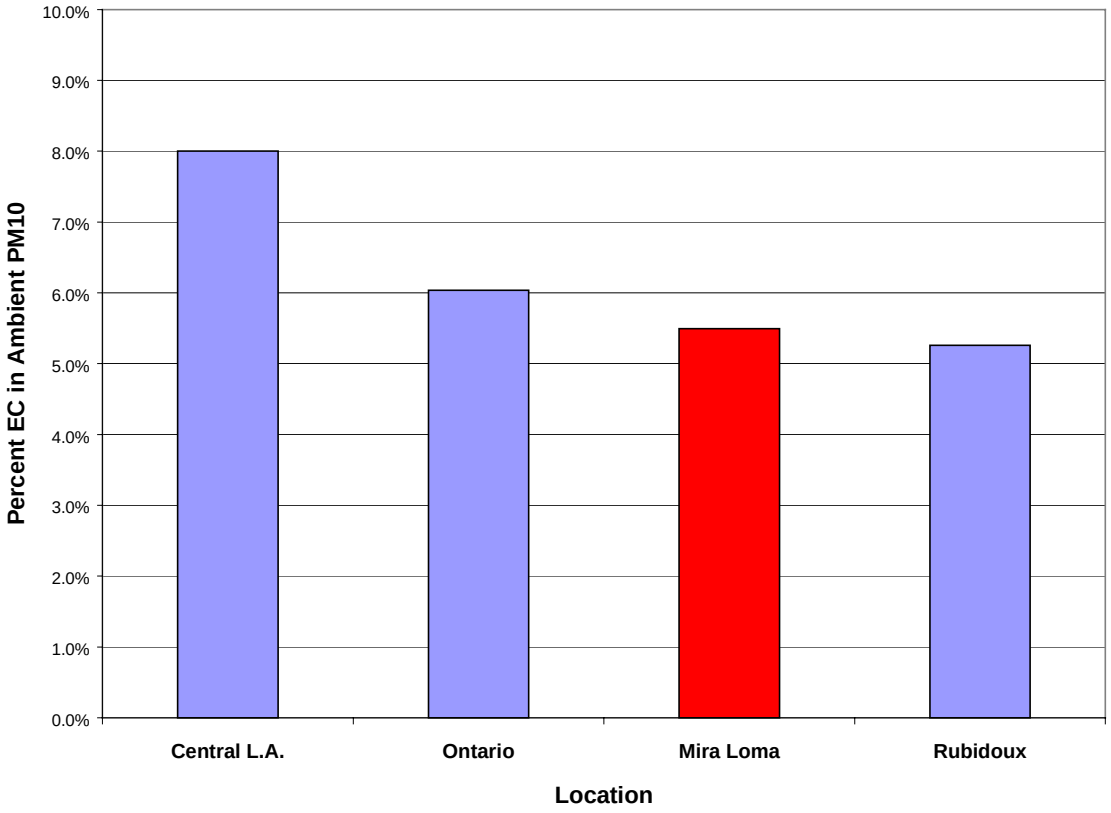
Figure 3: Average Elemental Carbon Concentration Error Analysis



The magnitude of the difference in EC concentration from site to site is not large. Figure 3 reproduces the data in Figure 2, with the addition of error bars. The error involved in the sampling and analytical processes, including errors in air volume measurement, filter weighing, and carbon analysis have been estimated. Error bars indicating the magnitude of the propagated measurement uncertainties (displayed with bold lines extending above and into the bars on the graph) were then added to the EC concentration data. A shaded box representing the top and bottom of the error bar for Mira Loma has been extended across the graph.

Using analysis of variance techniques, it was determined that the differences in reported EC concentrations from site to site are not statistically significant at the 95% confidence level. This means that from a statistical standpoint the average EC levels are not different from each other.

Figure 4: Average Percent EC in Ambient PM_{10}

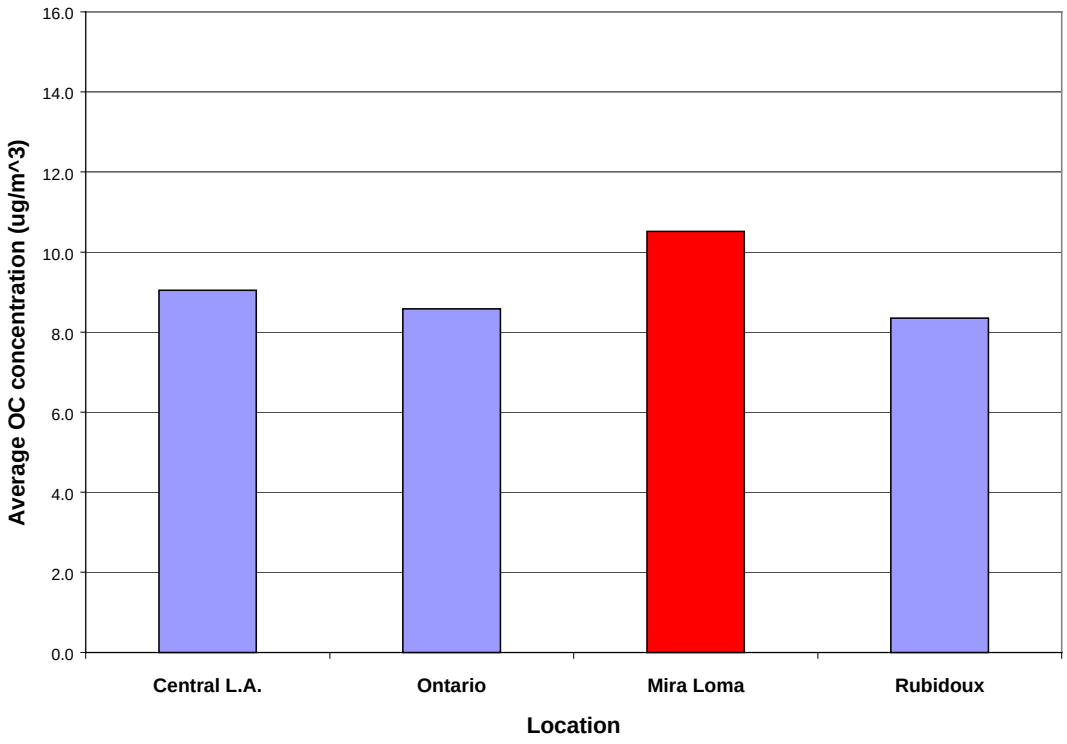


The percentage of EC in PM_{10} was calculated, and is displayed in Figure 4 above. In contrast to the raw EC ambient concentrations expressed in Fig. 2, calculating the percentage of EC in PM_{10} gives a better sense of the whole composition of the particulate collected. In this case, the Mira Loma PM_{10} has a percentage of EC between that observed for Ontario and Rubidoux. So, though Mira Loma EC concentrations appear slightly higher, as in Fig. 2, there are higher levels of other chemical species in the Mira Loma PM_{10} as well.

In this analysis, the percentage of EC in PM_{10} decreases steadily from west to east, from Los Angeles toward Rubidoux. This reflects a progression from areas with particulate composition dominated to a greater degree (proportionately) by heavy-duty vehicle traffic (L.A.), toward more rural areas with particulate composition dominated to a greater degree by crustal materials and other chemical species (Rubidoux).

3.3 ORGANIC CARBON ANALYSIS

Figure 5: Average Organic Carbon Concentration by Site



Organic carbon concentrations were averaged for each site over the duration of the study, and results are represented in Fig. 5 above. Complete data tabulation can be found in Appendix I. Mira Loma had the highest OC concentrations during the study. There are many sources of organic carbon that contribute to particles, however fine particulate (e.g. < PM_2) carbon source apportionment research conducted by Schauer, et al.,[4] indicate that re-entrained road dust is a contributor. Further, recent evaluations[5] on PM_{10} data collected as a part of the CHS, indicate that re-entrained road dust is likely to be a significant contributor to organic carbon PM_{10}.

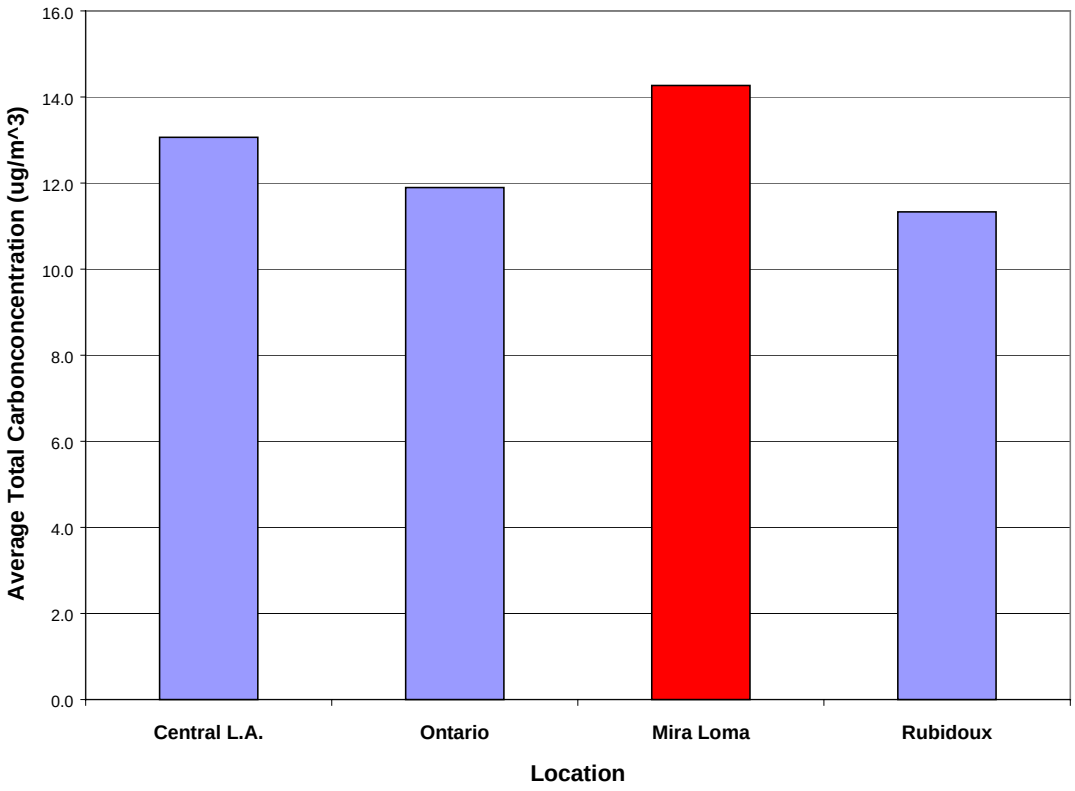
The high OC levels also contribute to the relatively lower percentage of EC in PM_{10}, as discussed in section 3.2.

[4] Schauer, J.J., Rogge, W.F., Hildemann, L.M., Mazurek, M.A., Cass, G.R. Source Apportionment of Airborne Particulate Matter Using Organic Compounds as Tracers. *Atmospheric Env.*, **1996** 30 (22):3837-3855.

[5] Draft Report to the California Air Resources Board under Contract # 98-320.

3.4 TOTAL CARBON ANALYSIS

Figure 6: Average Total Carbon Concentration by Site



Average total carbon concentrations are represented in Figure 6. Mira Loma exhibited the highest average total carbon result for the study period. As the EC concentration was only slightly elevated (not elevated by a statistically significant amount), the higher total carbon value for Mira Loma primarily reflects the higher OC value, discussed in section 3.3.

4.0 CONCLUSIONS

1) Ambient PM_{10} concentrations at Mira Loma exceeded those observed at Rubidoux, traditionally the highest PM_{10} site in the Basin.

2) Ambient elemental carbon was slightly elevated, possibly due to increased diesel traffic in the area. However, the magnitude of the increase is not elevated enough to be statistically significant. When expressed as a percentage of PM_{10}, the elemental carbon concentrations at Mira Loma follow patterns previously observed in the basin: decreasing EC content in PM_{10} as sampling locations move from west to east, caused by a decreased contribution from mobile sources, and an increased contribution from crustal materials and nitrate species.

3) Organic carbon concentrations were elevated at Mira Loma, due likely to the local influence of re-entrained road dust. The OC concentration is a major contributor to the high total carbon concentrations observed.

4) In short, although there may be some increase in ambient EC due to increased diesel truck traffic, it appears that a combination of local sources, topography, and/or meteorological conditions yield not only increased EC, but increased OC and PM_{10} in general. The increase appears to place Mira Loma among the highest PM_{10} sites in the Basin.

APPENDIX I MIRA LOMA PM_{10} MONITORING DATA

PM_{10} Ambient Concentration Results

Location	12/2/00	12/8/00	12/14/00	12/20/00	12/26/00	1/1/01	1/7/01	1/13/01	1/19/01	1/25/01	1/31/01	Average
Central L.A.	80	26	41	79	71	66	65	31	60	25	37	53
Ontario	93	28	44	85	68	*	72	35	66	31	41	56
Mira Loma	141	36	57	123	38	106	90	45	73	33	33	70
Rubidoux	131	35	53	104	46	67	75	41	49	29	20	59

* No Sample

Organic Carbon Ambient Concentration Results

Location	12/2/00	12/8/00	12/14/00	12/20/00	12/26/00	1/1/01	1/7/01	1/13/01	1/19/01	1/25/01	1/31/01	Average
Central L.A.	10.2	3.9	6.7	13.7	11.6	12.1	9.2	7	11.3	5.8	8	9.0
Ontario	12.5	3.5	6.8	14.2	8	*	9.8	7.9	11.4	6.5	5.2	8.6
Mira Loma	20.1	5.5	7.9	16.3	4.7	16	13.1	10.7	11	7	3.4	10.5
Rubidoux	16.2	5.3	7.3	12.7	4.5	12	9.4	9.5	6.9	6.1	1.9	8.3

* No Sample

Elemental Carbon Ambient Concentration Results

Location	12/2/00	12/8/00	12/14/00	12/20/00	12/26/00	1/1/01	1/7/01	1/13/01	1/19/01	1/25/01	1/31/01	Average
Central L.A.	5.5	2.6	2.5	6.1	5.3	4.5	4.6	2.8	3.6	2.2	4.5	4.0
Ontario	6	2.3	2.4	5	2.7	*	3.8	2.2	4.4	2.1	2.2	3.3
Mira Loma	6.1	2.6	3.2	6.4	0.7	5.4	4	4.7	5	2.5	0.6	3.7
Rubidoux	4.1	2.7	2.2	5.9	0.9	4.7	3.3	2.7	4	1.9	0.5	3.0

* No Sample

Total Carbon Ambient Concentration Results

Location	12/2/00	12/8/00	12/14/00	12/20/00	12/26/00	1/1/01	1/7/01	1/13/01	1/19/01	1/25/01	1/31/01	Average
Central L.A.	15.7	6.4	9.2	19.8	17	16.6	13.8	9.8	14.9	8	12.5	13.1
Ontario	18.5	5.8	9.2	19.2	10.7	*	13.6	10.1	15.8	8.6	7.4	11.9
Mira Loma	26.2	8.1	11.1	22.7	5.4	21.4	17.1	15.4	16	9.5	4	14.3
Rubidoux	20.3	7.9	9.5	18.6	5.4	16.7	12.7	12.2	10.9	8	2.4	11.3

* No Sample

Elemental Carbon as a Percentage of Total PM_{10}

Location	12/2/00	12/8/00	12/14/00	12/20/00	12/26/00	1/1/01	1/7/01	1/13/01	1/19/01	1/25/01	1/31/01	Average
Central L.A.	6.9%	10.0%	6.1%	7.7%	7.5%	6.8%	7.1%	9.0%	6.0%	8.8%	12.2%	8.0%
Ontario	6.5%	8.2%	5.5%	5.9%	4.0%	*	5.3%	6.3%	6.7%	6.8%	5.4%	6.0%
Mira Loma	4.3%	7.2%	5.6%	5.2%	1.8%	5.1%	4.4%	10.4%	6.8%	7.6%	1.8%	5.5%
Rubidoux	3.1%	7.7%	4.2%	5.7%	2.0%	7.0%	4.4%	6.6%	8.2%	6.6%	2.5%	5.3%

* No Sample